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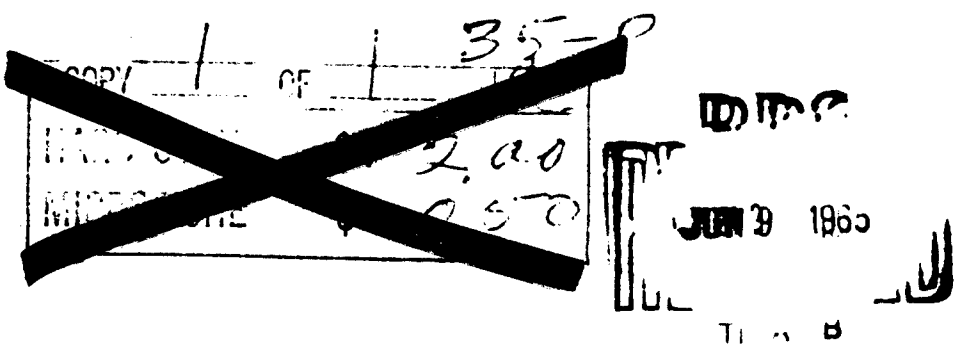
AUTHOR John T. Salisbury



RE-ENTRY SYSTEMS DEPARTMENT

GENERAL ELECTRIC

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A STUDY ON THE APPLICATION OF MICROFILMING TO THE PRODUCTION, DISTRIBUTION, USE, AND RETRIEVAL OF TECHNICAL REPORTS

By

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30 April 1965

GENERAL ELECTRIC

RE-ENTRY SYSTEMS DEPARTMENT

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FOREWORD

It is generally recognized that traditional Engineering techniques and methods are fast becoming reshaped and automated to keep pace with competition. Until recently in this Country, engineering data and reports have also remained in their traditional forms, that is, as full-size printed pages. The fact of keener competition coupled with the sheer bulk of paper in Engineering files is virtually demanding that a condensed form of report format and presentation of data be implemented. Such a condensed form is the microfiche, and it is finding its way into diverse applications in the many Technical Documentation Management Centers throughout Industry and Government.

The standard microfiche is a 4 x 6 in. film sheet containing a series of microimage pages of a report. It is designed to replace, and in many instances to supplement, the conventional printed report (commonly called hard copy), which is a familiar item in our daily routines.

With the passage of time and with greater emphasis placed on mechanized retrieval methods, it is predicted that microfiche will attain a position of prominence over hard-copy reports.

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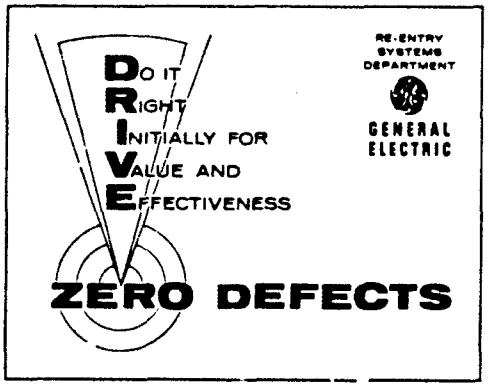

INTRODUCTION

The Problem of Growing Documentation

1. Each year millions of dollars are spent by the Federal Government for research, engineering design, and development of hardware by companies active in the aerospace industry. The growing problem of effectively managing, distributing and using the enormous mass of information produced has become complex and acute.

During a tour of the U. S. Department of Commerce's Clearing House for Scientific and Technical Information, it was learned that many companies in the defense business are beginning to translate research information into a system that will ensure its most effective use, reduce required storage space, and speed up and simplify report distribution and submittal to the Federal Government and subsequently to the scientific and technical community.

Spurred in large measure by an enthusiastic acceptance from Federal Government information specialists, a system for disseminating information rapidly and economically to multiple user points was devised and is now in operation: this system is called microfiche. The receiving area in the Clearing House is shown in Fig. 1. Approximately 70,000 report titles are processed onto microfiche each year.

Figure 1. Receiving Area at the Department of Commerce Clearing House

The system of microfiche offers promising documentation control factors and cost reduction benefits in handling and using the great number of written reports printed annually by the Re-entry Systems Department (RSD). Microfiche lend themselves to automated page retrieval techniques, which are presently in the planning stage of development in this Country.

Documentation Management

2. The goal of a coordinated effort in documentation management should ultimately be one of producing fewer reports having more value while meeting all contractual obligations. This goal means that the reports needed to conduct a business will have much more value because everyone's concern is aimed at producing and retaining for retrieval only those reports having a permanent historic value. Reports having short-lived value of perhaps one month or less should obviously be prepared and printed in a manner compatible with estimated usefulness.

Effective management is concerned with retrieval of information it needs when it is needed. Our records and reports in RSD should serve to direct, to instruct, to inform, and to document historically for the express purpose of planning, organizing, controlling and producing our hardware products, and in measuring their successes. In reaching this encompassing goal, the objective of eliminating unnecessary and duplicate paperwork is implied and understood. As each objective is achieved, the microfiche will exact a conspicuous part in the advancing technology of applied documentation management.

A Recommendation for Microfilming

3. According to Mr. M. Day, Director of Scientific and Technical Information Division, National Aeronautics and Space Administration, the average technical report is not to be kept on an active status list for more than six months. The technology is of such a volatile character that the value of such reports is very questionable, once the six month period has been exceeded. He also indicated that less than ten percent of the report material is used for subsequent reference and publication. Therefore, a change is mandatory in the manner in which a technical report is prepared for printing, is stored for subsequent reprinting, and is distributed. Mr. W. Carlson, Director of Technical Information, Department of Defense, believes that the only logical answer to this problem is to institute a microfilming capability into existing technical publication organizational structures.

Identified in Table 1 are the major advantages and disadvantages of the presently available methods of producing various microfilms for use in information

retrieval systems. A significant aspect of the data presented in this table is that the folio microfiche method is most economical for a low work volume of approximately 3000 pages per month, while the unitized microfiche system offers greater economies as the work volume increases above the 3000 page per month minimum. The microfilming methods identified in Table 1 are roll film, jacket microfiche, microfolio microfiche, and unitized microfiche. Each system is briefly described in the following paragraphs:

1) Roll Film

A planetary camera and a film developer constitutes the equipment required to produce a roll of microfilm. This roll of microfilm is of silver film composition and is subject to scratch. Because of this weakness it is common practice to duplicate the roll, thus generating a working diazo copy.

2) Jacket Microfiche

The jacket method requires the same equipment used in the roll system and in addition it requires other equipment to cut the roll into strips and insert the strips into the mylar or acetate jackets. The use of the jacket system was the first step toward making a microfiche.

3) Microfolio Microfiche

The microfolio system requires the application of an adhesive tape to the edges of a roll of microfilm. Special equipment automatically lays the strips of microfilm on a sheet of acetate in a predetermined order. This is called the microfiche master and since it is composed of silver film it is desirable to make a film diazo copy of the master microfiche.

4) Unitized Microfiche

The unitized system is a marked departure from the use of 16 or 35 mm roll film. The unitized system uses roll film in making a microfiche, but the width of the film is not 16 or 35 mm; it is 105 mm – approximately 4 in. . Also, a step-and-repeat camera is used to capture some 60 images in a precise grid pattern directly onto the 105 mm film that will accommodate 200 microfiche, each being 148 mm long – approximately 6 in. .

TABLE 1. MAJOR ADVANTAGES AND DISADVANTAGES OF VARIOUS METHODS OF MICROFILMING TECHNICAL DOCUMENTATION

CHARACTERISTICS	UNITIZED MICROFICHE	FOLIO MICROFICHE	JACKET MICROFICHE	ROLL FILM
ADVANTAGES				
Simple to duplicate	X	X		X
Low initial cost of equipment			X	X
High speed processing of film	X			X
Simple to revise		X	X	
Simple to index for retrieval	X	X	X	
Minimal storage space	X	X	X	
Economical for processing high work volume	X	X		X
Economical for low work volume		X	X	
Economical for duplication to make multiple distribution	X	X		
Easy to use as reference	X	X	X	
DISADVANTAGES				
High equipment expense relative to other systems	X			
High manpower expense in making microfiche		X	X	
Not suitable for duplication			X	
Difficult to make a single-page film copy				X
Easily damaged	X	X	X	X

Governmental Interagency Agreement on Microfiche Standards

4. Three Government agencies have standardized in the use of the unitized microfiche system. They are the Atomic Energy Commission (AEC), the National Aeronautics and Space Administration (NASA), and the Department of Defense (DOD). In operation, the unitized microfiche system will be used to reproduce all R&D reports originating from the agencies and their contractors. DOD's unclassified documents will be processed by the U.S. Department of Commerce's Office of Technical Services (OTS). The AEC, NASA, and DOD publish more than 90 percent of the scientific and technical reports sponsored by the Government.

During the first six months of 1964, increasing acceptance by other Government agencies of NASA's microfiche resulted in further standardization of its size and format. In April 1963, NASA and AEC agreed to develop identical standards for reduction ratios and frame spacing in their microfiche. In addition, the Federal Council for Science and Technology directed all executive agencies to adapt the microfiche method for their reports. These developments paved the way for commercial suppliers to concentrate on simple, more efficient, and less costly designs of equipment to produce microfiche.

A microfiche standard for documents 8-1/2 x 11 in. or smaller has been established by the National Microfilm Association (NMA). The NMA standard identifies four acceptable microfiche sizes: 75 x 125 mm, 105 x 148 mm, 5 x 8 in., and 3.25 x 7.375 in.. A reduction ratio of 18:1 to 20:1 is specified with a fixed frame size. An announcement was recently made that all Government Agencies will standardize on the 105 x 148 mm size (approx. 4 x 6 in.) early in 1965.

Microfiche System Justification

5. A microfilming capability in the Technical Publications Component (TP) could solve immediate problems of filing, storing, protecting and retrieving records by producing both a microfiche and offset masters. The microfiche would be used in a reference file for information retrieval purposes and for producing additional microfiche and hard-copy reports for distribution. An all-microfiche distribution system would result in greater economies in both manpower and material costs. The typical microfiche can be produced for less than fifty cents, whereas a hard copy of the same report may cost from four to eight dollars. It is recognized that there will be some resistance to the acceptance of a microfiche as a substitute for hard copy by individuals not acquainted with the tremendous potential of microfilm in general and microfiche specifically. To accommodate any immediate scepticism, it is planned to produce offset masters, as a by-product of the microfiche. Offset masters are used to produce the conventional hard copies required for short-lived memos and reports with little or no historic value. Areas of further evaluation for justification of the uniquely dynamic system of microfilming can be derived from:

- Labor savings on a Department-wide basis
- Speed of data distribution
- Less printing of hard-copy reports
- Less engineering time used in data retrieval
- Less file space
- Reduced postage and shipping costs of hard-copy reports
- Less bulk in internal handling
- Security benefits

Since a 4 x 6 in. microfiche negative may contain approximately 60 miniaturi pages, a total of 3,315,000 pages of conventional repro masters can be stored in a file, the size of which is now in use in RSD. By the simple conversion to 4 x 6 in. file drawers, all documents produced by RSD can be easily indexed for immediate retrieval In Fig. 2 is illustrated the storage capacity of a typical microfilm storage cabinet. For the engineer's use, a 55,000-page microfiche file occupies the same amount of desk space as a telephone. Such a file might contain certain frequently used standards, specifications, catalogs, and so on.

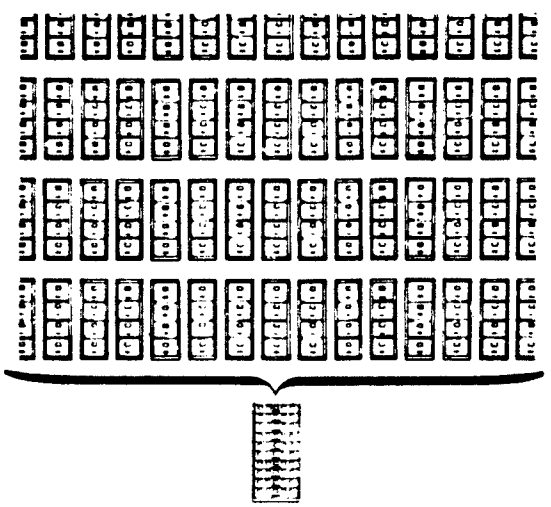

Figure 2. Storage Ratio of 4-Drawer Files to Microfiche File

Anticipating an eventual government requirement for the transmittal of microfiche reports rather than hard copy, it has been determined that microfilmed reports can be readily transported to the customer*. In the event hard copy is also required, arrangements can be made so that hard copy can be produced by the customer from supplied offset masters. The use of this device will reduce administrative costs for both the customer and RSD.

In addition to economizing on the delivered report, another advantage of the system is the reduction of work required in the distribution process. Present practice is to physically verify that each classified printed document contains the espionage clause (Title 18) and the destruction designation as well as conforms to the information set forth on the security cover flap. A typical external distribution often requires the services of more than two document distribution inspectors for many hours. In contrast, the entire classified microfiche distribution can be inspected and prepared for shipment by one person in a fraction of the time now required.

A substantial reduction in transportation costs could be realized by sending the classified microfiche external distribution by registered first class mail. The present procedure is to have the hard copies hand carried by a courier or employ the service of Air Express - Armed Surveillance, to meet crucial delivery schedules.

The use of microfilm would give RSD a complete, full-page retrieval system capability which is not in effect at the present time. In addition, it would also yield benefits of a less tangible nature in the information retrieval area. For example, microfilm can be employed during the review of a complete bibliography at the end of the reporting cycle on each of the major contracts.

Through the use of microfilming application techniques coupled with existing and planned computer data-storage programs, copies of past reports can be made more readily accessible. With the help of microfilm readers, researchers can review published reports and then easily reproduce those pages that are of immediate interest or are needed to generate a new report. The use of these techniques would eliminate the need for storing large bulky reports, and would prevent possible delays in obtaining copies of graphs and data.

Limitations of Roll Microfilm Method

6. Roll microfilm, without question, is excellent for some purposes. Banks use it for filming checks, and industry, on a limited basis, uses it for filming little used, historical files. However, active technical reports must be used on a daily basis, and the average report contains about 60 pages. Therefore, the problems become significant when a researcher must retrieve a selected few pages contained in a multi-report roll of microfilm. Such technical documentation users as the Department of

*NASA, AEC and DOD

Commerce, who use both small and large scale amounts of microfilm, have found roll film cumbersome for locating specific documents. Also, it is generally difficult, wher working with roll film, to add new material in its proper location, to interfile documents and to distribute individual documents. In addition, certain dangers in processing exist in the use of roll film, such as film breakage and the destruction of individual page frames.

Limitations of Jacket Microfilm Method

7. Nonuniformity is a reason for not using roll film in film jackets as original microfiche negatives. Another reason is the difficulty encountered when making microfiche from negatives in film jackets, since the film must be removed from the jacket to assure maximum legibility. Contact prints of microfiche made from original negatives require direct contact between the emulsion of the negative and the emulsion of the print. If such contact does not exist, diffusion occurs, and consequently a drop in image sharpness results. No loss in sharpness can be tolerated because the slightest diffusion is magnified 18X during blow back.

DESCRIPTION OF MICROFICHE

The Microfiche

8. Microfiche is a French word that has come to describe a sheet of film containing microimages. Introduced into the United States in 1962, the microfiche has an initial advantage over roll microfilm by its index-card presentation and form. Shown in Fig. 3 is the 4 x 6 in. microfiche, recently adopted as the standard size by DDC, NASA and AEC. Each small image on the microfiche was originally a letter-sized page. One 4 x 6 in. microfiche contains approximately 60 such miniaturized pages. The microfiche can be used for reading the document and for making photographic positive or negative copies for additional distribution. Attendant with the use of the microfiche are other mechanized features of retrieval access to new information

This study is concerned primarily with the methods of making two types of microfiche: the microfolio microfiche and the unitized microfiche. Each method is defined and discussed later in this report.

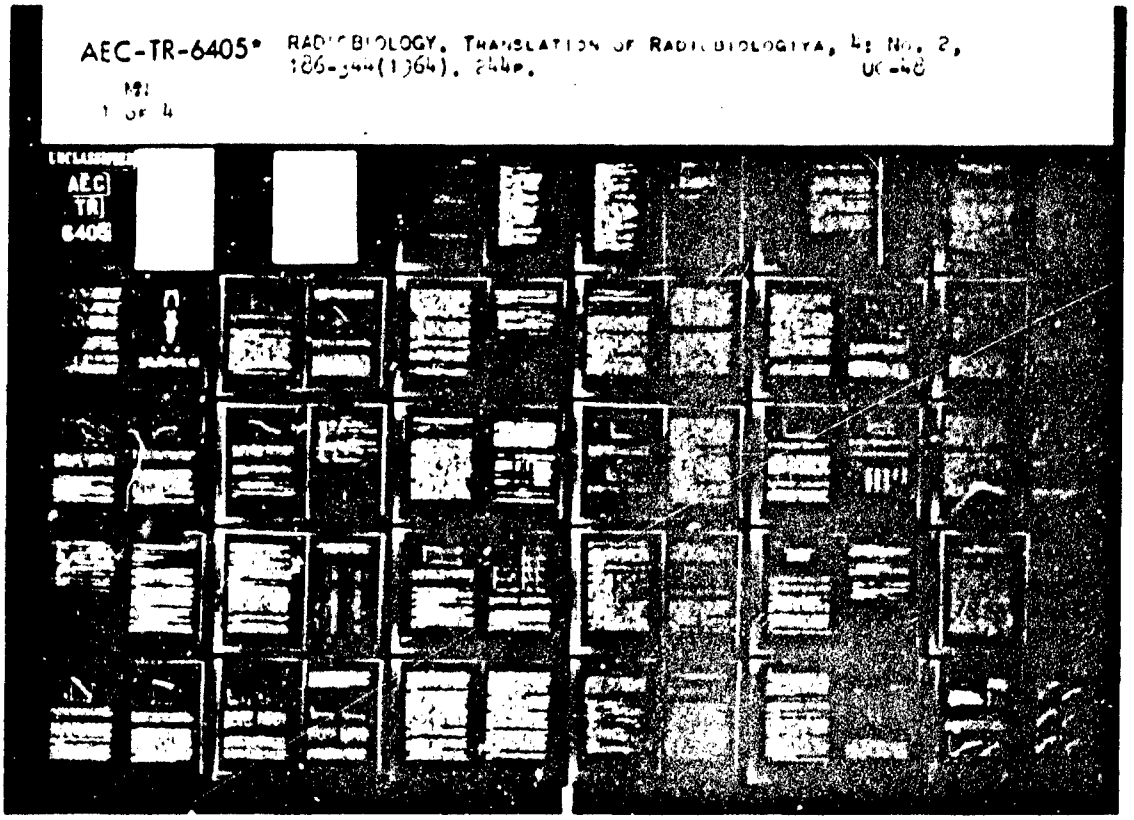

Figure 3. Illustration Showing a Typical Microfiche

Nearly all microfiche are composed of two or three fundamental parts, but mostly only two parts. When three parts are included, they are:

1) The heading

This is a description of the document and may contain the publisher's name, the title, the author and classification or identifying numbers. Located at the top of the card, this information is readable with the naked eye, as seen in Fig. 3.

2) The microtext

In a microfiche, the pages are normally in sequence in rows beginning with the upper left hand corner and reading from left to right. Occasionally, pages will run in columns from top to bottom instead of in rows, but this sequence is generally reserved for special applications.

3) The abstract

The third possibility is the inclusion of the document abstract somewhere on the microfiche. The document abstract is normally readable with the naked eye and gives a summary of the document highlights. This technique is best suited to double-sided microcards. This system, however, has not gained acceptance.

Types of Headings

9. Two types of headings are used. The most common heading consists of information running the full width of the microfiche across the top. Classification or identifying numbers are found in either top corner, or in both. To simplify page location, the heading usually contains the page numbers found on that microfiche and the number of microfiche found in that particular set. Accurate and descriptive information is essential to easy location of material.

The full-width heading is usually produced as a separate item in the process of making the original negative. The heading and the microtext are processed separately and then taped together on one mask — a process called stripping. The stripped negative is the master from which all copies are made.

Another method of producing the heading eliminates the stripping process and makes the heading one or several of the first few frames. One inch to 1 1/2 in. letters are usually used in the heading mock-up during filming operations. When reduced to the microframe size they are still legible to the naked eye.

Additional labor for the stripping operation is not required in this system, and the negatives are easier to maintain and use when they are in one piece. Unitized negatives of this type are often kept in a roll to facilitiate high speed printing of additional copies.

Reduction Ratios

10. Any reduction ratio is possible with the microfiche, but only a few are practical. For normal 8 1/2 x 11 in. material a reduction ratio ranging between 18:1 and 20:1 is recommended. By using an 18:1 ratio, for example, 60 pages will fit in a 4 x 6 in. area. The average technical report today ranges between 40 and 70 pages; thus, the page requirement and available space for pages are generally compatible.

One important point about format cannot be overstressed. Once a format, a reduction ratio, and microfiche size have been established there must be uniformity from sample to sample and within each sample. Pages or frames cannot be sloppily located. All frames must line up in rows or columns. Any deviations or errors will be magnified 15 to 20 times when the material is enlarged from the microimage.

Silver Film and Diazo Film Microfiche

11. The two most common film stocks for producing duplicate microfiche from original negatives are silver film and diazo film. Each has its good characteristics as well as certain drawbacks. Silver film is generally preferable for storage and record purposes; it retains its image much better with time. With use, diazo may fade after a few years. Silver film copies can be exposed faster than diazo copies, since diazo is a relatively slow film. Speed is important for high production of microfiche, and the overall duplicating cycle favors diazo over silver film, since diazo takes less time to develop. In addition, diazo film has the advantage of being a dry process that can take place in a lighted room. Concerning costs the two film materials are approximately equal, but diazo is cheaper to process in small quantities.

Diazo film offers the advantage of making a negative image from a negative. Silver film reproduces a positive image from a negative, thus requiring extra steps to produce a negative microfiche. The original silver-film master should be subjected to as few machines as possible to prevent its being torn or scratched. In all cases, the original master is made on silver film. Several different types of film bases are available in both the diazo and silver. However, diazo rather than silver seems less susceptible to scratching.

Other film stocks are gaining in importance, but to date they have been used only in moderation for microfiche. One such film is processed by the exposure to a mercury vapor lamp and to the simple application of heat.

Reason for Negative Microfiche

12. A negative microfiche is recommended for primary use as a master copy intermediate for the reproduction of full-size pages. Microfiche is excellent for this purpose, and it is also used for direct reading. Most microfiche images are intentionally made as negative images to reproduce positive, full-size hard copies. However, microfiche with positive images is desirable for use on a microfiche reader where there is a frequent occurrence of photographs. Negative photographs are difficult for

most people to read.

Use of Microfiche as Reproduction Masters

13. The present procedure used at RSD to produce hard copy consists of typing the manuscript onto repro mechanicals. The repro mechanicals are then delivered to the print shop where either a negative or a direct image plate (ITEK) is made. A negative is used to produce a metal plate, which is then the printing plate. After the printing cycle is completed the hard copies are sent to document distribution for delivery to both internal and external recipients. The length of time required to produce the hard copy after the repro mechanicals are received at the print shop frequently exceeds six working days. In addition to the time involved in printing and distributing the documents, many material category dollars are expended in using such means as air express-armed surveillance to deliver hard copy to the RSD customer interface (usually an RSD field representative). The delivery cycle cannot be completed until the field representative has unpacked the hard copies, inspected them for adherence to security regulations, logged, and forwarded them to the customer. By using a single microfiche as a reproduction master, the microfiche can be mailed to the customer representative for use in making hard copies as may be required by our Government Agency Customer.

Revising Reports on Microfiche

14. It has been the practice of personnel in TP to retain repro mechanicals used to generate the hard-copy reports during one fiscal quarter. This practice is based on a matter of economy. Repro quickly piles up and eventually, its bulk cannot be adequately indexed, stored, and retrieved. However, there may be a need for the repro in reprinting or revisions. With a file of master microfiche, any single microfiche may easily be revised by photographing a new repro page and by stripping the correction into the microfiche.

Flow Cycle in Making and Using Microfiche

15. The flow chart shown in Fig. 4 offers conceptual guidelines for establishing a system capable of handling the volumes involved while providing the Technical Publications Component and the Re-entry Systems Department with the additional benefits of microfilm. The proposed system takes into consideration the entire scope of the anticipated coverage required. All other Departmental components and operations that may be affected are included. The flow sequence in the proposed production and use of microfiche is as follows:

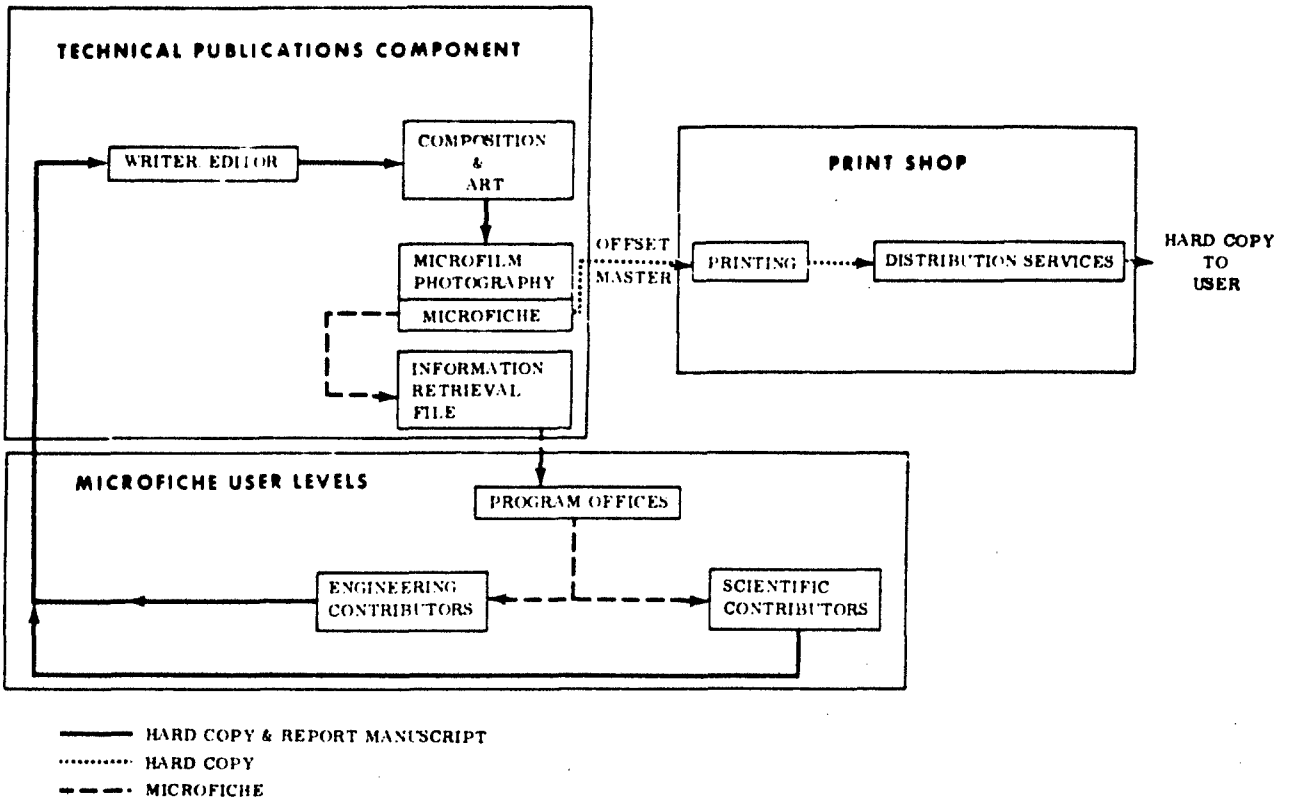

Figure 4. Flow Cycle in Making and Using Microfiche

1) The manuscript of hard copy is received by the Technical Publications Component from the engineering or scientific contributor.

2) The writer/editor examines the manuscript for editing and format and prepares an abstract and key word list.

3) The manuscript together with the abstract and key word list is routed to the composition and art units for processing into mechanicals. The mechanicals are then processed into microfiche.

4) Hard copy is processed similarly with additional steps in the cycle. The writer/editor prepares the abstract and key word list for typing by the composition unit. This together with the hard copy is routed to microfilming for processing into microfiche and offset printing masters. The offset master is then routed from TP to the print shop for direct printing of hard copy.

5) Long before the hard copy is available for distribution to the external customer, the microfiche has been duplicated and distributed to the internal customer.

6) The master microfiche and the necessary duplicates are retained in the mechanized information retrieval files for reference and for use in preparing additional hard copies (should the predicted supply fall short of the initial demand) and for use in revising the hard copy or microfiche, when necessary.

7) Microfiche are distributed to Program Offices for internal distribution to the scientific and engineering contributors. Microreaders will be strategically located in the Program Offices and the engineering and scientific work areas.

Microreaders will be retained in the Technical Publications area. Others will be located in the Program Offices and in the Engineering work areas.

Advantages of Microfiche

16. The advantages of microfiche include reference to accessibility, economy, clarity, speed, durability, and security.

1) Accessibility - localizes and reduces search

- Large bodies of information can be broken down into smaller, easy-to-handle units so that more than one person at a time has access to the microfiche file.

- Later additions to the main body of information can easily be interfiled on additional microfiche.

- Eye-legible indexing cuts down searching time making refiling easy and fast.

2) Economy - cuts production costs

- Cuts production and printing costs by eliminating costly preparation steps of the printing process. It costs less than 50 cents to produce one microfiche for the first sheet (a typical 60 page R&D report can be positioned on one microfiche), and less than 25 cents for each additional sheet.

- Less bulk means savings in mailing and distribution costs.
- Permits economical reproduction of additional microfiche copies.
- Full-size hard copies can be made even from second or third generation microfiche.
- Microfiche can be used on a simply constructed, inexpensive reader.

3) Clarity - superior image quality

- Complicated diagrams, tables, illustrations and material in color can have a full range of values possible only with translucent film.

4) Speed - in production and distribution

- By eliminating intermediate preparation steps, microfiche produced from original copy can be distributed effectively and quickly to multiple points, so that current information can be utilized.
- Of additionally required copies is possible.
- Of selected portions of the microfiche needed can be easily reproduced.

5) Durability - long life of microfiche

- Made of film stock 50 percent heavier than conventional microfilm, long-life microfiche stand up under extensive field use. Life expectancy is as great as a good grade of bond paper; the duration is about 100 years.

6) Security - less administrative time

- Since the original films are kept in-house, microfiche provides the best insurance against information loss or damage, provided the ambient temperatures to the files is never permitted to exceed 180°F. Any processing, handling, or filing of microfiche should be done under normal room temperatures.

METHODS OF PRODUCING MICROFICHE

Microfolio Microfiche Method

17. In Fig. 5 the equipment necessary for the microfolio microfiche method and the use of the functional product is identified. Manuscripts and reports submitted to Technical Publication Component for processing are filmed on a planetary microfilm camera. This camera is a variable focus camera, featuring image excellence and simple operation. It uses 35 mm film which is 100 ft. long. The film is unperforated for use on a daylight loading reel. The camera may be set for any single film advance up to 2 in.

The exposed film is developed in a silver film processor which processes either 16 or 35 mm microfilm, in any length from a complete roll down to a two-foot strip. The processor automatically does the complete job of developing, fixing, washing, and drying. No darkroom is required.

The developed microfilm is then processed through the microfolio applicator. This unit applies a crystal clear, special adhesive to the outer edges of the film roll. The time required for this phase is three minutes per 100-ft. roll, of either 16 or 35 mm film.

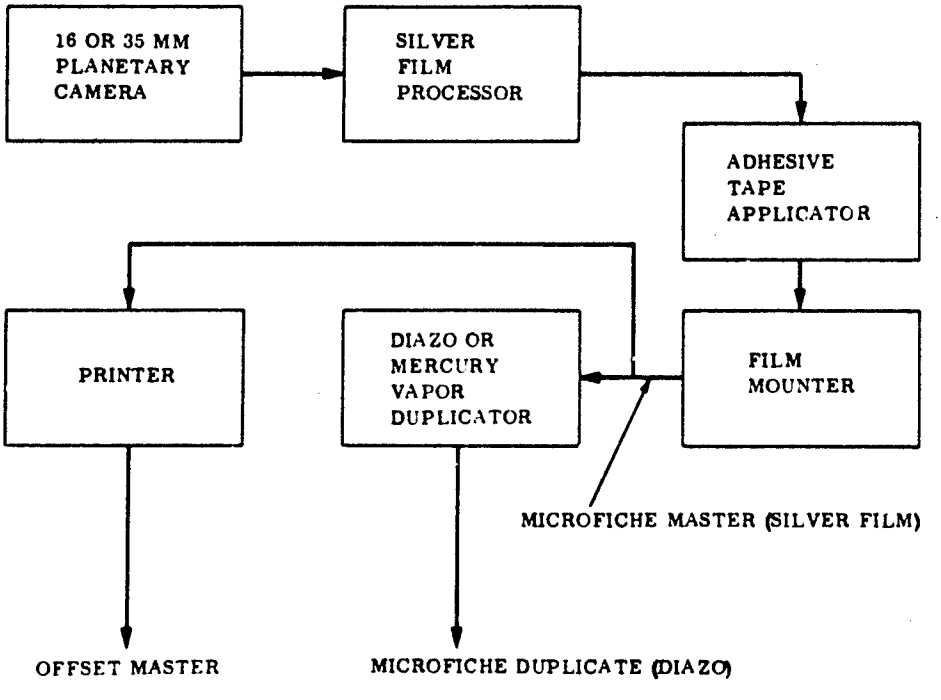

Figure 5. Flow Cycle for Microfolio Microfiche Method

The roll is then routed to the film mounter where it removes the vinyl protective backing from the adhesive and automatically advances the film for mounting on acetate sheets.

The product from the film mounter is a microfiche master (the silver film mounted on a 4 x 6 in. sheet of acetate). The microfiche master is fed through a diazo printer for producing microfiche reference copies on a demand basis. Reproduction copies are completely dry, fine resolution and inexpensive. The master can then be immediately returned to its file.

Hard copies are generated from an offset master which can be produced on a printer such as the Xerox 1824.

The microfolio master microfiche can provide any number of exact, completely dry, duplicate copies, quickly and inexpensively, without ever leaving the record filing area. This unique feature eliminates the problem of "incomplete" or "unavailable" records. Copies can be retained indefinitely or destroyed. Also, as a vital Engineering support function, microfiche will provide an up-to-the-minute reference data file. Complete duplicate files of indispensible records can be made quickly at minimal cost.

The microfolio microfiche method is very flexible and is the least expensive of the practical microfiche methods. The system accommodates any size reduction or format using 16 or 35 mm film, separately or combined. In addition, it allows for additions or deletions of images, thereby assuring an updated version of any particular information at all times.

Unitized Microfiche Method

18. In Fig. 6 the equipment and product used and produced by the unitized microfiche method is identified. Report manuscripts submitted to TP are processed as follows:

1) Report manuscripts are typed and prepared for microfilming. The resulting repro mechanicals are filmed on a step-and-repeat camera.

This camera utilizes a 100-ft roll of 105 mm film and produces, depending upon the make and model used, approximately 200 unitized microfiche negatives per roll at an 18X reduction with resolution of not less than 125 lines/mm.(1)

(1) - Present resolution is exceeding 135 lines/mm using the NBS 1010 Microcopy Resolution Test Chart.

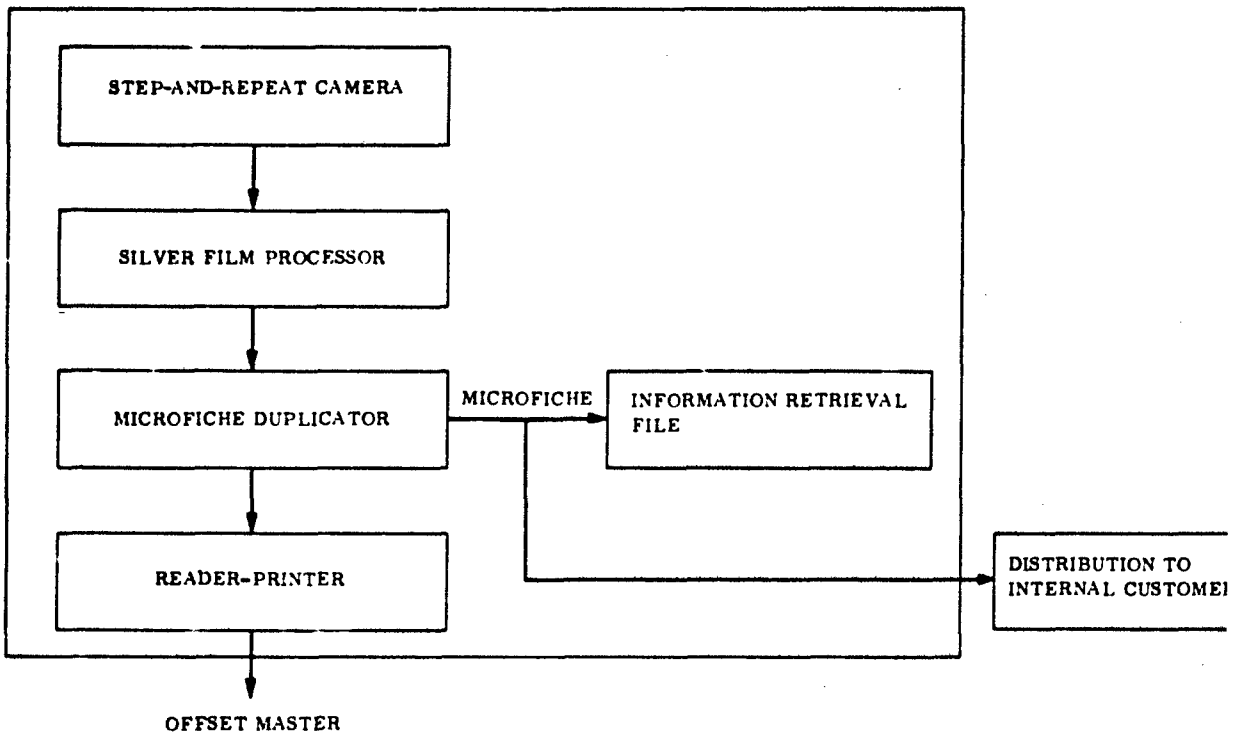

Figure 6. Flow Cycle for Unitized Microfiche Method

These microfiche are 4 x 6 in. and have a maximum capacity of 30 frames or 60 pages.(2) They are made to the standard adopted by the National Microfilm Association for technical reports.

The step-and-repeat camera utilizes an accompanying console which controls the camera and shows the operator the frame being processed. The camera also includes an automatic integral titler which reproduces the report title, accession number, etc., at the top of the microfiche.

After the 100 ft. of film have been exposed, the roll of silver film is removed from the camera and developed. The result is a roll of silver film containing approximately 200 negative microfiche.

2) This roll of silver film becomes the master negative. Using a Techifax unit. shown in Fig. 7, duplicate diazo film microfiche are printed for immediate

(2) - When more than one microfiche is required to reproduce a document, "trailer" fiche with a maximum capacity of 72 pages each are used.

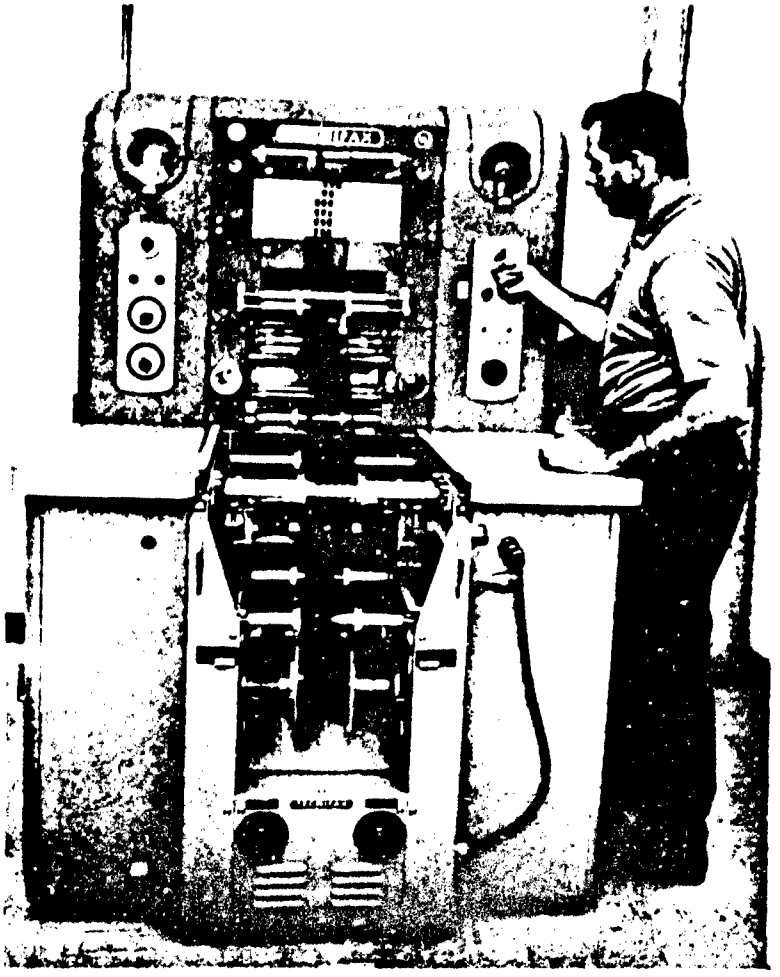

Figure 7. Reproduction Machine for Making Diazo-Copy Microfiche

distribution. A diazo working master will also be printed from which duplicate microfiche copies and enlarged copies will be made in the future. In the case of reports submitted to TP on microfiche (AEC, NASA) the microfiche received becomes the working master.

Once duplicate diazo rolls have been printed, the silver master negative is stored and not used again unless it becomes necessary to produce a new working master. The rolls, including the working master, are cut on an automatic cutter into individual microfiche which are then microscopically inspected for imperfections. The result is one fiche per report except in cases of long reports requiring trailer microfiche.

3) Enlarged copies of hard-copy reports are supplied through use of a step-and-repeat enlarger, a machine which has a 25,000 page-per-day capacity.

When an enlarged copy of a report is required, the working master is pulled from the appropriate file and inserted in a grid or fiche holder. The grid

and the programming slip for the microfiche are placed in the step-and-repeat enlarger. As the grid automatically cycles so that one frame after another is exposed at a rate of 3000 pages per hour, a photoelectric cell scans the programming slip for automatic adjustment of exposure for halftones, etc., and for automatic shutoff after the last frame is processed. Though reports are normally printed out at 60 percent of their original size, 8 1/2 x 11 in. reports can also be produced.

The previously mentioned National Microfilm Association standards for microfiche were of vital importance to hard copy reproducibility as they adopted a number of specifications which precisely regulated the position of each frame on the microfiche, thus opening the way for the use of automated equipment. Such standardization was an absolute necessity as no equipment which automatically goes from frame to frame and line to line can be produced unless every frame is in exactly the same place on every fiche.

The 500-ft. exposed roll of silver base paper produced by the step-and-repeat enlarger is subsequently routed to a processor, such as the Kodak Ektaline 200, which processes at a rate of 24,000 pages per hour and then cut on an automatic cutter. The resulting sheets are stapled between covers and the report is ready for distribution.

4) If the request is for a microfiche copy rather than hard copy, the working master is pulled from the file and a duplicate diazo copy is made.

Thus, one microfiche working master negative, such as those attached in Appendix A answers three requirements — initial distribution to standing orders, microfiche distribution to fill incoming orders, and hard-copy distribution to fill incoming orders. In addition, the working microfiche master provides high density storage as 100 fiche (6000 pages) can be filed in a linear inch of drawer space. Shipping charges are minimal as an unclassified microfiche, containing a sixty-page report, can be mailed for five cents.

EQUIPMENT SURVEY AND COSTS

Selection of Microfiche Equipment

19. The microfilm equipment manufacturers are responding to the demands placed upon them by an impatient aerospace industry. The available microfilming equipment is rapidly approaching a state of practicality both in usefulness and cost.

It is this environment which gives the potential user of microfiche a broad and diversified array of equipment. We are at the point of reaping benefits from the embryonic development of a most dynamic microfilming industry.

A number of major equipment manufacturers submitted specifications for our examination with the admonition, "Wait until you see the equipment that will be exhibited at the National Microfilm Association's convention to be held during May of this year at Cleveland, Ohio." In addition to performing a specification study of the various pieces of equipment, several unitized and microfolio systems located in Springfield, Virginia, Washington, D. C. and Daytona Beach, Florida were observed in actual operation.

A list of our surveyed microfiche equipment presently available, follows:

MICROFILM PLANETARY CAMERAS

MODEL	MANUFACTURER	REMARKS
MRD-2	Recordak	Medium volume planetary; 16 or 35 mm film; designed for NMA format; automatic focusing; 5 X to 21 X reduction; accepts data 26-1/4 x 36-3/4 in.; produces microfolio microfiche
IBP1400	ITEK	Medium volume planetary; variable-focus; NMA accepted; variable reduction ratio; produces microfolio microfiche
PD1400	Photo Devices, Inc.	Medium volume planetary; continuously variable reduction ration 12 through 20; uses 16 or 35 mm film; NMA accepted; produces microfolio microfiche

CONTACT FILM PRINTER

MODEL	MANUFACTURER	REMARKS
K10	Kalvar Corp	High resolution; semi-automatic vacuum frame printer; uses 400 watt mercury vapor lamp; high speed copy film printer
IBP302	ITEK	Absolute contact; controlled illumination; uniform film advance; prints copy film at 90 feet per minute

MICROFILM STEP-AND-REPEAT CAMERAS

MODEL	MANUFACTURER	REMARKS
SR-1	Microcard	High volume step and repeat; designed for NMA format; automatic cycling; 105 mm film; 18 X reduction, standardized format, 16 mm x 23 mm frame; locator panel shows camera position on film at all times; produces unitized microfiche
PD-1	Photo Devices, Inc.	High volume step and repeat; 10 X to 26 X reduction; 105 mm film; image to image accuracy within .005 in.; produces unitized microfiche; camera is in final commercial testing phase

MICROFICHE READER-PRINTERS

MODEL	MANUFACTURER	REMARKS
M-16A	Polydex	Electrostatic
FILMC:		
100MF	3M	Electrolytic
200R	3M	
300	3M	
Magnaprint	Recordak	Silver
Mark II	Documat	Silver (several variations available)
1824	ITEK	Silver
473	Federal	Needs stabilization processor

(Note: In some reader-printers larger microfiche may have to be turned upside down to accommodate all the pages. This does not affect printing capability.)

MICROFICHE-HARD COPY ENLARGERS

MODEL	MANUFACTURER	REMARKS
EL-3*	Microcard	High volume 5,000-25,000 pages/day range; step-and-repeat; automatic; silver; designed for NMA format
1824	Xerox	Manual operation; 500-2,000 pages/day range
1014	ITEK	Manual operation; 2,000 pages/day range

*Available on service bureau basis only. For on-site production operated by Microcard Corporation.

MICROFICHE READERS

MODEL	MANUFACTURER	REMARKS
Micro III	Microcard	Portable, reads microcard and microfiche
Mark IV	Microcard	Designed for use with new NMA format
KL-58	Griscombe	
KL-46	Griscombe	Maximum size 105 mm x 148 mm
PKL-58	Recordak	
PKL-46	Recordak	Maximum size 105 mm x 148 mm
A	Dagmar	Maximum size 75 mm x 125 mm
F	Documat	
F458	Remington	

MICROFICHE READERS (Cont'd)

MODEL	MANUFACTURER	REMARKS
F446	Remington	Maximum size 105 mm x 148 mm
MF1	Bell & Howell	Maximum size 105 mm x 148 mm
576	Dukane	Maximum size 105 mm x 148 mm
MJR-85	Atlantic Microfilm	
PFC46	Recordak	Maximum size 105 mm x 148 mm
MF2	Bell & Howell	105 mm x 148 mm optional holders for 75 mm x 125 mm and 5" x 8"
200	Documat	Several variations available
COMB12133	Dagmar	

(Note: All readers take up to 5" x 8" size microfiche except as indicated.)

Equipment and Labor Estimates

20. The equipment and labor estimates which follow are approximate costs estimated to be within 10 percent of actual costs. The costs are given in this manner so that nearly all manufacturers' equipment are included in the representative systems. The manufacturer of equipment considered most appropriate to our needs include: Microcard Corporation, ITEK Corporation, Bell and Howell, Recordak Corporation and KALVAR Corporation.

The cost savings with respect to filing derived by the use of either microfiche system are considered the same, making it unnecessary to include costs for files in the following system costs:

Microfolio Microfiche System	Purchase and Lease Costs
Including: roll film camera, silver film developer, tape applicator, mounter microfiche duplicator, and hard-copy reader-printer	$ 6,000
Labor costs per year (4 heads)*	$20,000
Total	$ 26,000

*Labor estimates are based on the assumption that the microfilming capability will be part of the existing Technical Publications Component.

Unitized Microfiche System	Purchase and Lease Costs
Including: step-and-repeat camera, silver film developer, automatic cutter, microfiche duplicator, step-and-repeat enlarger, hard copy developer, and plate maker	$ 7,500
Labor costs per year (2.1 heads)*	$14,000
Total	$21,500

Reader for Engineering Usage	
Portable (Microcard)	$150 each
Stationary (Bell and Howell and other)	$300-$500 each

*Labor estimates are based on the assumption that the microfilming capability will be part of the existing Technical Publications Component.

CONCLUSIONS, RECOMMENDATIONS, AND COST SUMMARY

Conclusions

1. Summary type questions, such as "What happens to a microfiche copy of a report at the user's end?" and, "What does the researcher do with it?" are typical questions you may hear.

A person who receives a report on microfiche may: (1) read it using a microfiche reader; (2) make hard copy using a reader-printer; (3) duplicate the microfiche singly or in quantity to satisfy additional distribution. Both microfiche readers and reader-printers are currently available from many manufacturers.

2. A documentation center having a microfiche duplicator need not circulate its microfiche. A researcher can call the center from his office and request a certain report by number, the report is automatically sorted and retrieved from the microfiche file, and a duplicate microfiche, if needed, is made for as little as 8 cents for the researcher.

3. A reader-printer is useful when a person reading a report wants hard copy of a specific page. All he need do is push a button and wait about 15 seconds for the enlarged copy. Because of the exposure time involved, however, a reader-printer is not suitable for printing hard copy of an entire report.

4. A prototype step-and-repeat enlarger demonstrated not long ago will print out hard copy of the quality included in Appendix B and of an entire document automatically at a rate of 10 pages per minute or 4800 pages per day.

Recommendations

1. Allocate approximately 1000 square feet of work space, as listed below, with restricted area access for the purpose of establishing a microfiche capability in RSD. This area will require plumbing, 220-V electrical service, and air conditioning at 70° F.

		Sq. ft. of floor space
Camera	-	50
Developer	-	50
Film Cutter	-	30
Files	-	20
Storage Area	-	35
Desk Space	-	120
Copy Machine	-	25
Retrieval Files	-	25
Reader's and Researching Area	-	650
Reader-Printer	-	100

2. Implement the microfolio microfiche method immediately through lease and purchase of the required microfilming equipment for a 6-month pilot run. Estimated total costs are:

Equipment	Purchase ($)	Lease ($)
Camera, Recordak MRD-2 with 16 mm Adapter		115./mo.
Silver Film Processor		95./mo.
Tape Applicator	--	75./mo.
Mounter		60./mo.
* Colite Fiche Duplicator	745.	
* Kalvar Developer	285.	
* Xerox 1824 Printer	--	205./mo.
* Documat Reader-Printer	995.	
* Microcard FR-5 Reader (6) @ $150.00	900.	
* Randomatic Fiche Sorter	2000.	
Equipment Total	$4925	$550./mo.
Labor (4 heads - 6 mo.)	10,000	--
Total	$14,925	$550./mo.

* Same equipment for both methods. (Recommendations 2 and 3) Duplicate purchases not needed to implement the unitized microfiche method.

3. Implement the unitized method for producing microfiche with a target completion date 6 months from go-ahead. This installation should serve as a microfiche capability for RSD and MSD. The major items of equipment, such as the step-and-repeat camera, should be leased on a monthly basis and should be covered by contracted maintenance service. Estimated total costs are:

Equipment	Purchase ($)	Lease ($)
Microcard Step-and-Repeat Camera (**)	--	750./mo. (40 fiche up to 1250; .25 per fiche after that)
Photo Devices Step-and-Repeat Camera (**) (Selling price: $34,000)		1200./mo.
Developer (Selling price: $2,500)		85./mo.
Automatic Cutter (Selling price: $2,950)		95./mo.
*Colite Fiche Duplicator	745.	
*Kalvar Developer	285.	
*Xerox 1824 Printer	--	205.
*Documat Reader-Printer	995.	
*Microcard FR-5 Reader (6) @ $150.00	900.	
*Randomatic Fiche Sorter 1500	2000.	
Equipment Total	(*)	$1585/mo.
Labor (2.1 heads/yr.)	14,000	--
Total	$14,000/yr.	$1585/mo.

4. Establish a mechanized retrieval microfiche file on all Engineering data files, such as PIR's, specifications, design specifications, MIL Standards, and so on, for the immediate use of Engineering and other personnel.

Cost Summary

The total cost investment in purchased equipment, based upon recommendations 2 and 3 is $4,925.00

* Same equipment for both methods. (Recommendations 2 and 3) Duplicate purchases not needed to implement the unitized microfiche method.

** The leased cost total of $1585 includes the cost of just one camera @ $1200/mo.

The total estimated cost for leased equipment per year amounts to:

1st year

(Recommendation 2), $550 x 6	$3,300.00
(Recommendation 3), $1585 x 6	$9,510.00
Total	$12,810.00

2nd year

(Recommendation 3), $1585 x 12	$19,020.00

Since the second year leasing cost exceeds 50 percent of the purchase price of the step-and-repeat camera listed in recommendation 3, it is further recommended that the balance of equipment leased be considered for purchase.

APPENDIX A

SAMPLE MICROFICHE OF RSD DOCUMENTATION

(Included in envelope for selected distribution only)